CORNELL AGRICULTURAL ECONOMICS STAFF PAPER

Biotechnology: The Impact on Farm Firms and Regional Competitive Positions

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Staff Paper No. 89-21 **June 1989**

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BIOTECHNOLOGY: THE IMPACT ON FARM FIRMS AND REGIONAL COMPETITIVE POSITIONS*

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Introduction

Rarely has science created as much controversy as biotechnology has in the food sector. Biotechnology is damned as leading to the demise of the family farm and lauded as the secret to eliminating hunger. Expert predictions range from little or no response to unprecedented increases in productivity such as those in the OTA report that among other predictions forecast a doubling in milk produced per cow within 20 years.

To date the products of biotechnology have hardly caused a ripple in productivity trends. The earliest dramatic impacts will likely come from enhanced protein synthesis in animals (growth hormones) where the impact of biotechnology is indirect in that biotechnology is used to economically produce the growth hormone. Major impacts from direct modification of plants and animals is predicted to follow.

In my opinion, biotechnology will have major implications for the rate of productivity growth, for farm firm structure, and for regional competitive advantage. The productivity increases will, however, be significantly less than indicated by results from research trials because response rates will be highly variable. The factors affecting adoption, the magnitude of the response, and the impact on profitability are discussed in the first section. In the second section, the outcome on farm firms is assessed with the third section directed toward the impact on regional competitive positions. The paper concludes with some implications for the dairy industry and farm business managers.

The dairy industry will be utilized as an example for much of this paper. The reasons for this choice are the availability of data, my familiarity with the industry, the likelihood of bovine somatotropin approval in the next year, and the composition of the audience.

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* Presented at Biotechnology Seminar Series, Department of Animal Science and Michigan Experimental Station, Michigan State University, East Lansing, Michigan, June 5, 1989.

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Factors Affecting Farm Firm Response[1]

Knowledge of the economics and management of farm firms and an understanding of the biological response from biotechnology can be used to adduce the factors that will determine the impact of biotechnology on dairy farm firms. The factors are:

1.) Attitude toward management and management skill of the manager;

2.) Quality of available resources;

3.) Financial health of the business;

4.) Business size.

Attitude Toward Management and the Management Skill of the Farm Business

The range in productivity in farm firms is amazing. Table 1 is an example for dairy production in New York. No one argues that the major determinant of this range is interherd variation in genetics (Elliot). This means the variation must be determined by attitude toward management, management ability and/or by resource availability with the latter determined primarily by management in the long run. In other words, the primary limitation to current productivity levels and, therefore, determinant of the variation, is the level of management in the business.

On most farms the management limitation is not the management ability of the manager(s) but rather the failure to give management the priority it must have to maximize the success of a farm business. Evidence for this claim is threefold: 1.) most farmers will readily admit that they fail to utilize even the recommended practices they have learned, 2.) most managers admit management is given second priority to labor, and 3.) farm businesses where management is clearly given priority almost always have good productivity and profitability.

The management attitude and ability of individual operators will be critical to the successful economic use of biotechnological advances. Numerous biological and economic variables can affect biotechnology performance. The interactions between these variables and changing economic conditions will challenge the management abilities of farm operators. Moreover, many of the relationships will not be known with exactitude at the time these products are introduced into commercial use.

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[1]This section is adapted from Kalter and Milligan (1987).

Farm businesses are also becoming larger and more complex. Profitable businesses will have to formulate long-range plans, position themselves to capitalize on market trends, purchase inputs economically, manage personnel effectively, and implement mechanisms to monitor and control productivity and profitability. The required management skills are far broader than the operational management skills required to manage production.

Quality of Available Resources

High productivity levels require that plants and animals not be exposed to unnecessary stress. This requirement is difficult to meet if the business does not possess high quality facilities and soil resources. Farm businesses with limited resources will face two possible outcomes: productivity increases will be limited and/or those increases will be more costly. New technologies and improved management practices will increase the pressure on farm businesses with facilities that are technologically obsolete or in poor condition and on farms without excellent soil resources.

Good Financial Health

"Financial health" refers to the ease with which the business currently meets its debt-related commitments while paying current business expenses, maintaining the capital stock, and providing a reasonable level of owner/operator withdrawals. Financial health is, therefore, related to debt-to-asset ratio, but many other factors, particularly profitability, are also important. In general, financial health will positively contribute to successful adoption of biotechnologies. Good financial health will guarantee the capital availability necessary to adjust to changing industry conditions and to make any investments required to eliminate unnecessary stresses at the high levels of productivity associated with successful adoption. Good financial health will also enable the farm business to survive the weak economic period that is almost certain to be a part of the dramatic changes induced by biotechnologies.

It is important to add that these technologies will not necessarily be harmful to all farm businesses with poor financial health. If such a business can be an early adopter and/or a highly successful adopter, the added income could be utilized to improve the financial health and thereby enhance the probability of survival of the business.

Business Size

Most biotechnologies are directly size neutral because they do not require a capital investment. This is in contrast to technologies requiring capital investments; an example of the latter is the introduction of the bulk tank, which resulted in the demise of large numbers of small dairy farm businesses due to its up.front cost and the disproportionately larger increase in cost of production for small firms. Biotechnologies, on the other hand, do not directly alter the relative cost of production among alternative farm business sizes.

However, size will indirectly be a determinant of successful adoption of biotechnologies. First, size and profitability (and financial health) are positively correlated (Table 2) as are the other factors discussed above. In addition, the attainment of the high levels of productivity associated with successful adoption may require investments that are not size neutral. Examples include environmental controls, sophisticated production systems, and computerized information systems.

Biotechnology Impacts on Farm Firms

The simple answer to the question of which farm businesses will survive is those that possess excellent management skills, high quality resources, good financial health, and adequate business size. In terms of talking to farm managers considering how to position themselves to be competitive this is an important answer (Milligan and Smith, 1988). For our purposes in this discussion, we need to look more carefully at farm firm structure.

We begin by addressing what I believe is a crucial trend in agriculture today; namely, that the productivity and profitability difference between "top" farm businesses and the "average" farm business is increasing. This trend, which is really an hypothesis, is difficult to test because time series data for "top" producers is rarely available. Figure 1 compares production per cow for the top decile by profitability from the New York dairy farm business summary project (Smith, Knoblauch, and Putnam, 1987 and previous annual summaries) and the average for New York State (New York Agricultural Statistics Service, 1987). This figure illustrates this increasing difference in the 10 year period of 1977-1986. The annual increase was 2.18 percent for the top decile in the farm business summary compared to 1.16 percent for the New York average.

Figure 2 illustrates the widening of this gap if milk sold per cow increases at the rate of the last 10 years. Since the "top" producers generally have greater management skills, higher quality resources, better financial health, and larger businesses, advances from biotechnology will impact the "top" producers more than the average. For illustration, I have assumed that biotechnology will increase the annual productivity rate from 2.18 percent to 3.18 percent for "top" producers and from 1.16 percent to 1.66 percent per year for average producers. Figure 2 also compares the rates of increase based on the last 10 years and the higher rates with biotechnologies.

I believe the trends illustrated above for dairy farm businesses in New York State are occurring in many or most other agricultural commodities and regions. These trends, especially as biotechnology products become common, will place increasing economic pressure on farms that are above average but not outstanding. Many of these businesses now provide modest economic returns but will provide unsatisfactory returns if my predictions are on target. In many states, probably including Michigan, these farm businesses are our primary Extension clientele.

Impact of Regional Competitive Positions

The regions of the country where farm businesses are the least prepared to utilize the new technologies due to the reason cited above will be relatively disadvantaged by biotechnology. In this section I extend the dairy analysis and conclude with several general conclusions based on less definitive analysis.

This dairy analysis compares California, Wisconsin, and New York (USDA). California currently averages over 4,000 pounds more milk and its increase has been 0.5 percent per year greater over the last 10 years compared to Wisconsin and New York. If these rates are maintained, this difference would double in the next 20 years (Table 3).

With biotechnologies like bovine somatotropin, the difference between California and Wisconsin/New York productivities will only widen as it is generally accepted that the greatest response will occur in better managed, higher producing herds (National Invitational bST Workshop Committee, 1987). To illustrate, I assume that biotechnologies will add 1.0 percent to the annual increase for herds over 16,000 pounds per cow in 1987 and 0.5 percent for herds under 16,000 pounds. Using a standard deviation of 3,000 pounds obtained from an as yet to be published survey of over 700 New York dairy farm businesses, I estimated the percentage of cows in herds averaging over 16,000 pounds per cow in 1987. The percentages are 75, 23, and 18 for California, Wisconsin, and New York, respectively. The new projected productions (Table 3) show an even greater spread (Figure 3).

These results indicate that the spread in production per cow between California and Wisconsin, now at 4,000 pounds, could reach 8,000 pounds at current trends, and over 11,000 pounds with biotechnology within 20 years. As economists we know that differences of this magnitude are unlikely to be due to competition. This means major changes will occur in the dairy industries in the Lake states and the Northeast. The changes could generate a major revitalization of the industry and/or a major down-sizing of the industry.

A second impact of biotechnology that will have important implications to regional competitive advantage is that less total agricultural land will be required to meet the demand for agricultural products. Kalter and Milligan (1987a) estimate that the use of growth hormones in dairy, hogs, beef, and chickens would reduce national agricultural acreage needs from 3.4 to 10.0 million acres depending upon response rate scenarios[2] The magnitude of productivity enhancements in crops is impossible to estimate this early in the development process; however, their impact on total acreage would be direct and presumably of greater magnitude.

One plausible scenario for the feed grains and dairy areas, including the Midwest and the Northeast, is that biotechnology in crop production would result in a shrinking of the Corn Belt. The areas now on the fringe of the Corn Belt would then find farm businesses switching to dairy production. Major sections of the northern Lake states and the Northeast would struggle to maintain a viable agricultural industry.

Implications

In this section we will first discuss implications for those of us involved in dairy agriculture in the Lakes states and the Northeast and then comment on implications for farm managers. As I indicated earlier, farm businesses most impacted by these changes are our major clientele at least among dairy producers. I believe that we must address this challenge directly by conducting research and developing Extension curricula that will help producers become competitive with our best producers and with larger scale businesses in the Southwest and other regions of the country. This will require innovative programming to "force" producers to examine their attitudes toward management (Milligan, et al., 1987; Milligan, 1987), to improve their skills in managing the business and its personnel, and to mitigate the impacts of economies of size.

What then should farm managers do today to prepare for biotechnologies? The general answer to this question is to improve the business. Managers must manage the development of the business and its personnel. The larger the business the more time the manager spends managing people. Specifically, this paper will conclude with four business management recommendations:

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[2]This reduction is less than one might expect due to the expectation that porcine growth hormone will require a higher protein ration and thus increased soybean acreage.

1.) Farm business managers should acquire additional managerial/entrepreneurial expertise. They must learn what management is and how to manage. They should consider taking business courses at a local college, carefully observe managers of all types of businesses, and perhaps even pursue an MBA. The PRO-DAIRY in New York is designed to directly assist in this endeavor.

2.) An expansion in the size of the business should be considered. Larger firms will be in a better position to capture the economies of size of the capital-intensive technologies that may be required to obtain optimal productivity gains and will be able to obtain the necessary specialized management skills. The expansion should only be executed if management is excited about and prepared for the responsibilities that greater size will demand.

3.) Financial health should be strengthened. Managers must manage the business for maximum profitability, invest optimally in farm and nonfarm opportunities, and obtain optimal terms on financing even if nontraditional financing mechanisms are required.

4.) The land resources and the facilities should be reviewed for any necessary improvements. This review could include investigating the feasibility of relocating the business if the current resources are marginal.

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TABLE 1

Estimated Impact of a Ten Percent Sector Production Response on Non-Adopters at Various Productivities

Milk Sold Per Cow (pounds)[a]	Average Number of Cows	1986 Net Farm Income ($)[b,c]
Under 11,000	67	$ -3,316
11,000 to 11,999	76	11,874
12,000 to 12,999	68	7,781
13,000 to 13,999	75	8,521
14,000 to 14,999	74	15,162
15,000 to 15,999	87	18,929
16,000 to 16,999	99	23,916
17,000 to 17,999	103	29,939
18,000 and over	146	57,951

[a]Average of 414 New York dairy farm businesses (Smith, Knoblauch, and Putnam, p. 23)

[b]Net Farm income is an accrual measure of return to operator management and labor, unpaid family labor, and equity.

[c]$0.84 per hundredweight * number of cows * midpoint of milk sold subtracted from net farm income.

TABLE 2
1986 Herd Size and Profitability for 414 New York Dairy Farm Businesses[a]

Number of Cows	Net Farm Income[b]	Labor Management Income Per Operator[c]
Under 40	$ 6,845	$ -2,533
40 to 54	7,644	-2,168
55 to 69	16,164	1,361
70 to 84	15,600	-1,372
85 to 99	19,361	378
100 to 149	39,080	8,981
150 to 199	33,630	3,696
200 to 249	42,881	4,803
250 and over	123,246	42,319

[a]From Smith, Knoblauch, and Putnam, p. 22.

[b]Net farm income is the return to operator management and labor, unpaid family labor, and equity capital.

[c]Farm management income is net farm income minus a charge for unpaid family labor minus a five percent equity capital charge with the residual divided by the number of operators.

TABLE 3

Projected Milk Production Per Cow Using Current Rates of Increase and an Enhanced Rate Due to Biotechnology

	California	Wisconsin	New York
1987 Production Per Cow	17,970	13,816	13,242
1978-87 Annual Rate of Increase	2.23%	1.71%	1.72%
Projected Production in 2207 with 1978-81 Rate	27,993	19,393	18,624
Estimated Percentage of Cows in Herds Averaging > 16,000[a]	75%	23%	18%
Projected Additional Increase from Biotechnology[b]	0.880%	0.620%	0.59%
Increase with Biotechnology	3.11%	2.33%	2.31%
Projected Production in 2007 with Biotechnology	33,156	21,900	20,908

[a] Assumes normal distribution and standard deviation of 3,000 in pounds. I would hypothesize that the standard deviation would be less in California which would increase the percentage.

[b] Calculated as: proportion over 16,000 * 1.0 + proportion under 16,000 * 0.5. The assumption is that those over 16,000 will increase at a rate double that of businesses producing under 16,000.

Figure 1. NEW YORK MILK PRODUCTION PER COW, 1967-86

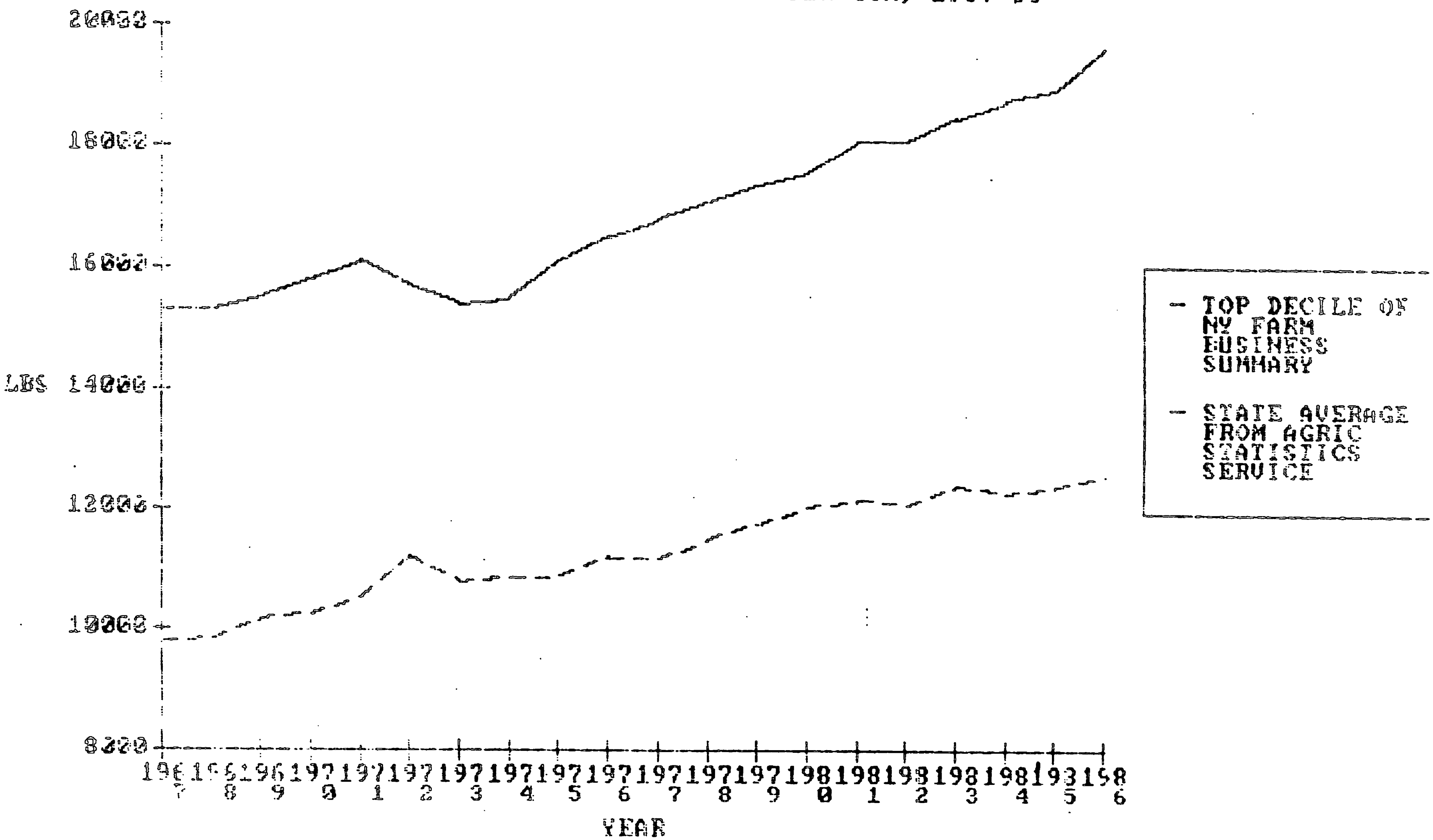


Figure 3. PROJECTED PRODUCTION PER COW - 1978-87 RATE AND BIOTECHNOLOGY, 1988-2007

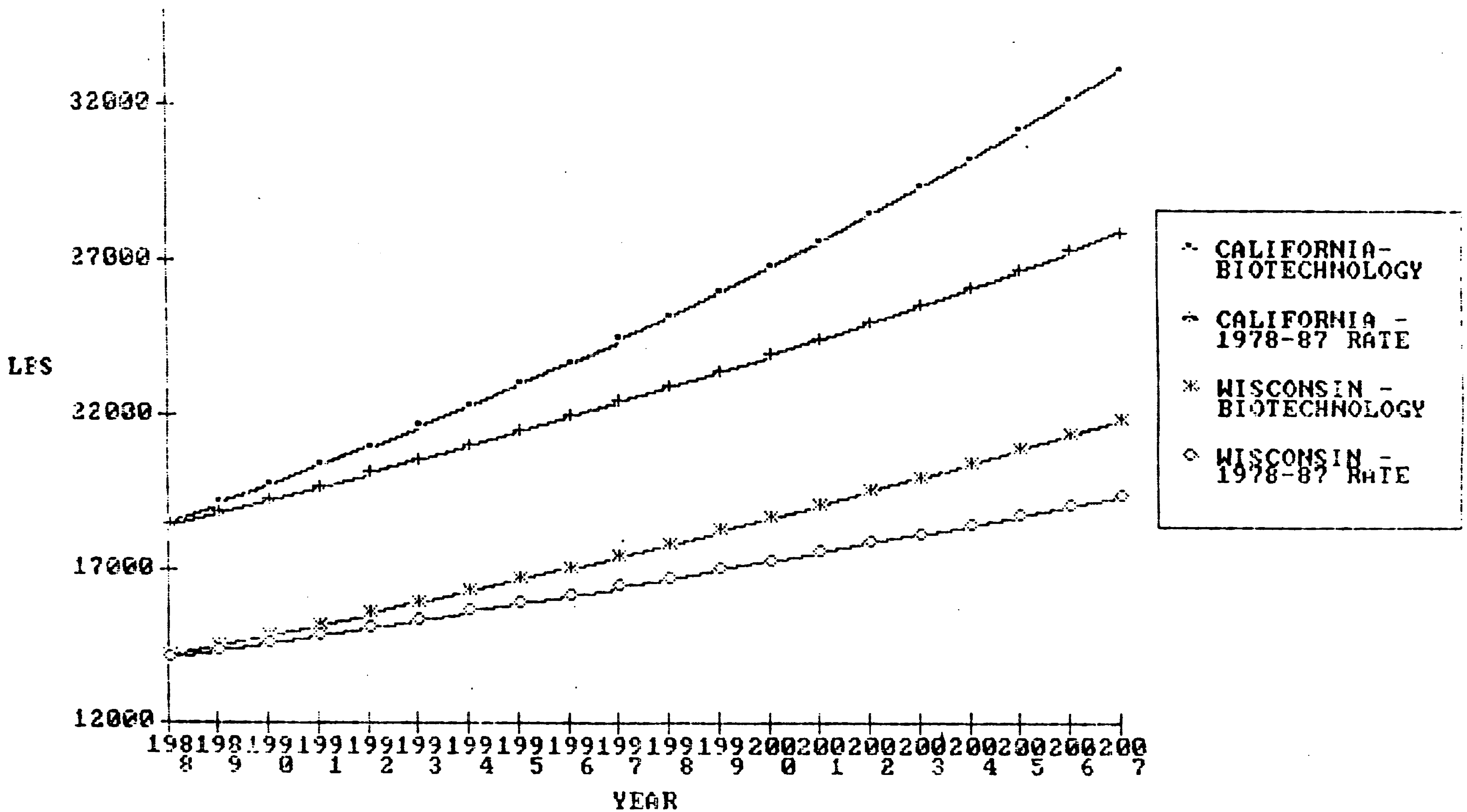
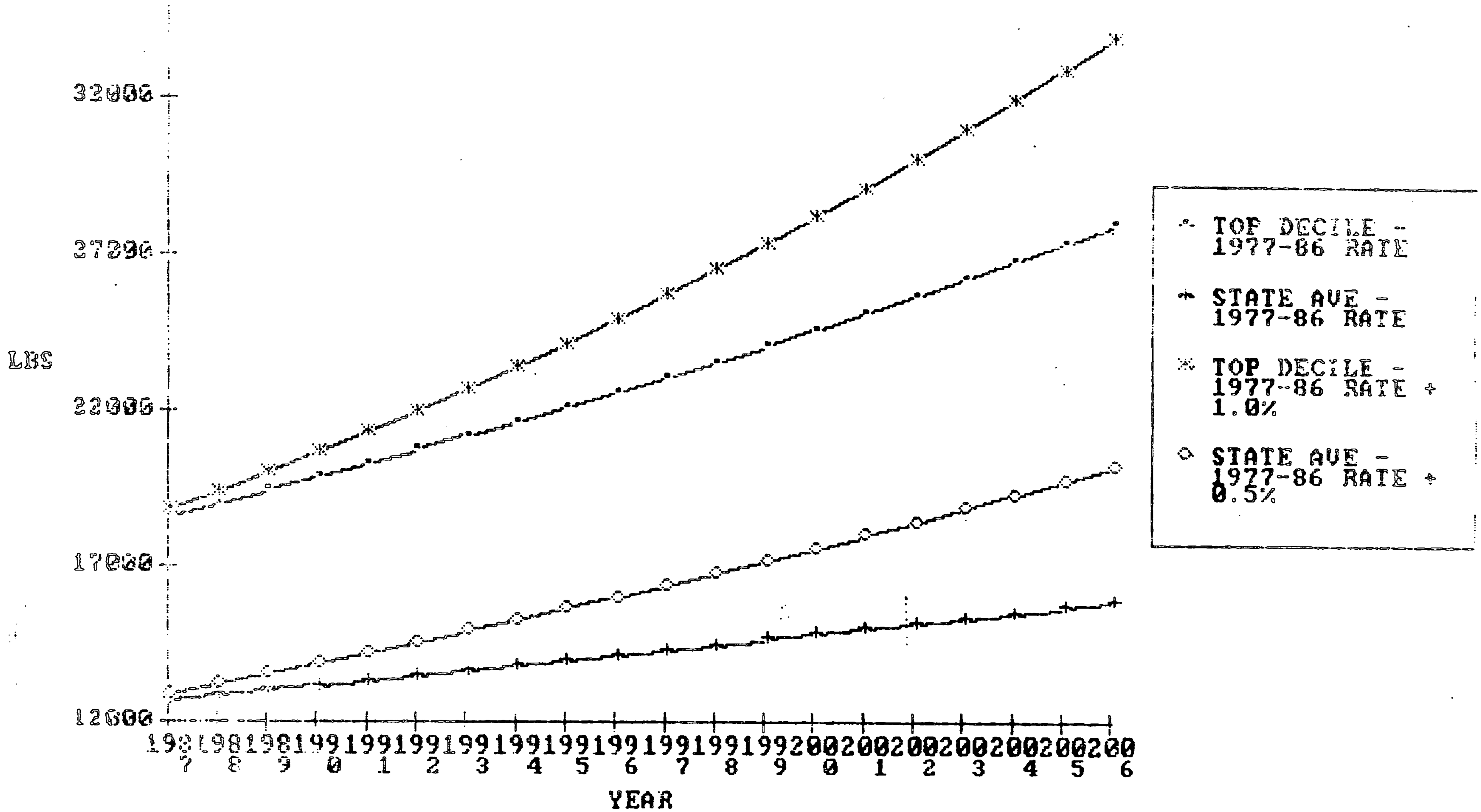


Figure 2. PROJECTED NEW YORK PRODUCTION PER COW WITH AND WITHOUT BIOTECHNOLOGY, 1987-2006



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